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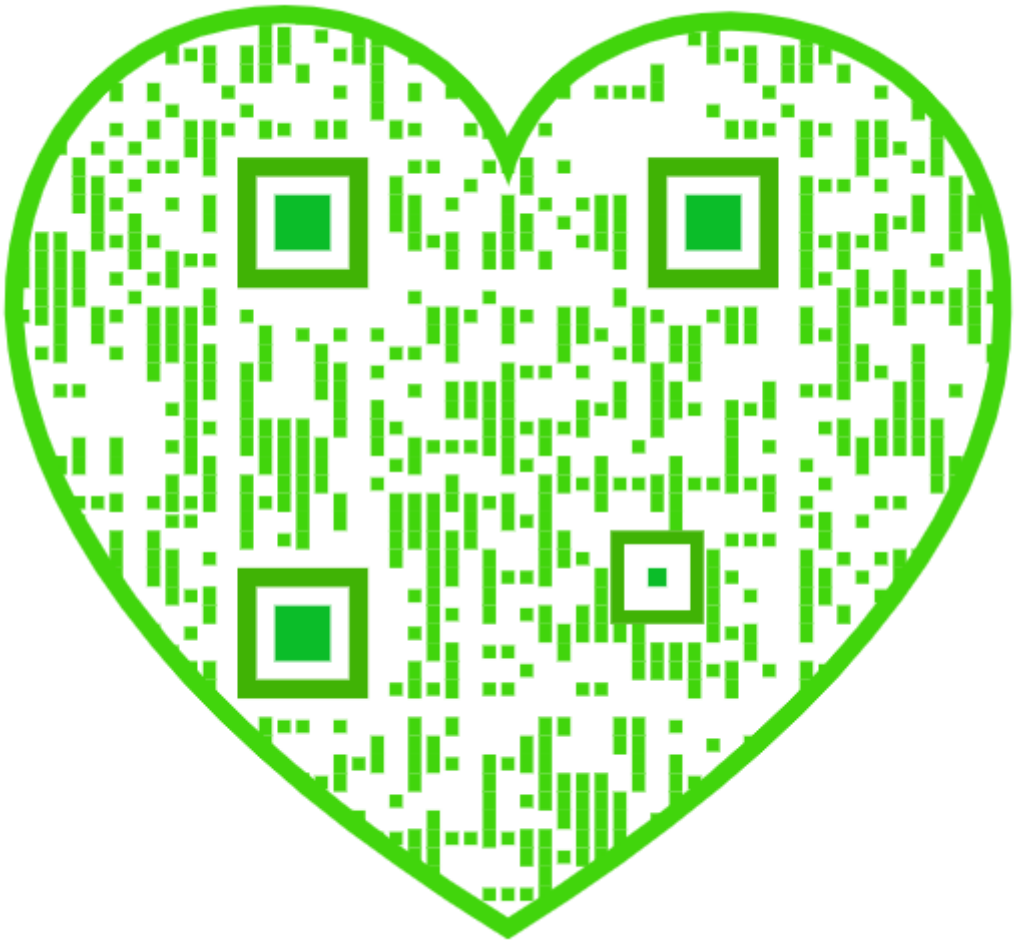

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The Estimation of Condition in Cattle.

BY

J. ALAN MURRAY, B.Sc.,

Lecturer in Agricultural Chemistry at University College, Reading.

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1914

PREFACE.

The following paper was read at the Meeting of the British Association in Australia this year, but owing to the outbreak of war and other causes it has not been reported in the papers. This is the more regretable because the paper was not designed to settle the question, but to open it—to invite criticism and co-operation. The author has, therefore, deemed it advisable to reprint it *in extenso* with this object in view. He will welcome any public or private criticism either of the general proposition or of details, such as the best method of making the measurements, expressing results, etc.: and he will be extremely glad to receive or to have his attention called to any data bearing on the subject.

J. A. M.

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The Estimation of Condition in Cattle.

BY

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Lecturer in Agricultural Chemistry at University College, Reading.

THE verbal terms used by farmers to describe the "condition" of animals, *e.g.*, "fat," "half-fat," "store," etc., are vague and indefinite. They are, however, in common use, and it would be futile to suggest that they should be changed or abandoned; but it is not, perhaps, inopportune to enquire whether a more definite signification might be ascribed to them. In order to ascertain what these terms connote in the ordinary language of those who use them, it is convenient first to consider the noun (condition) before attempting to deal with the adjectives.

The condition of cattle is usually judged by the appearance of the animals, the flexibility of the skin and so on; but these indications are not entirely satisfactory. The vagueness of the terms used to describe condition is, no doubt, due in large measure to the difficulty of judging it. The only exact method of expressing all the various degrees of condition is by means of numerical values, and if these are to be employed, the condition must be determined in a different manner.

The live weights are expressed by numbers. These vary with the condition of the animals, but they cannot be used as a general test of condition because they also vary with the size (extension of the frame). Thus, if two animals were in the same condition but one of them was bigger than the other it would weigh heavier. If two animals were of the same size but one of them was in better condition than the other it would weigh heavier. But if two animals were of the same size and in the same condition they would have the same weight.

It appears, therefore, that the term condition, as used in this connection, may be interpreted to mean that quality which is measured by the ratio of live weight to size. This view is more concisely expressed by the equation

$$C = \frac{M}{S}$$

where M is the live weight, S is the size, and C is a number which expresses the condition of the animal.

This proposition is not entirely novel, but, so far as the author is aware, it has not previously been expressed in exactly this form. It is well known that the weight of dressed carcass can be estimated, with more or less accuracy, from the size as determined by measurement of certain dimensions, viz., the length and girth of the animal. Several rules are given by which the result may be worked out. Most of them, however, apparently aim at simplicity rather than accuracy. Only one of them attempts to take into account the condition of the animal. This rule is generally rendered as follows: "the girth squared multiplied by the length (both in feet) and the product multiplied by a factor (·23, ·24, ·25, or ·27) according as the animal is moderately fat, fat, prime fat, or very fat, gives the weight of dressed carcass in imperial stones." If the factor which varies with the condition of the animal be designated by the symbol C and the length, girth and live weight by L, G and M respectively, the rule may be expressed in the form of an equation as follows:

$$M = C \times L \times G^2$$

It is generally considered that this rule, though better than any of the others, is not altogether trustworthy. This is attributable partly to the difficulty of making exact measurements and partly to the fact that the rule itself is radically unsound. Thus, if the factor C be evaluated in terms of the others by the usual methods we obtain

$$C = \frac{M}{L\ G^2}$$

Stated in this form it will be seen that the equation involves a contradiction in terms. When an animal becomes fat the girth increases to a certain extent (and C should become greater); but since G occurs in the denominator, any increase in the value of G tends to *diminish* that of C; and since G is squared, the error thus introduced may be considerable.

The object of the foregoing discussion was not primarily to criticise this particular rule, but to show that the proposition $C = M/S$ is an accepted idea. Incidentally it appears that S may be rendered by $L \times G$ (or some function of the same) provided that G represents the girth in store condition; in the case of fat beasts some allowance must be made for the increase of girth due to fattening. The equation may, therefore, be written provisionally as follows:

$$C = \frac{M}{L(G - X)}$$

In order to test the matter, and if possible to determine X, observations of the length, girth and live weight were made upon a number of animals, and these data, together with certain others derived from them, are given in the table below.

TABLE I.

STORE CATTLE.

Mark.	Live Weight. (M)	Length. (L)	Girth. (G)	$\frac{G}{L}$	$\frac{M}{L}$	$\frac{M}{G}$	Difference. $\frac{M}{L} - \frac{M}{G}$
	pounds.	inches.	inches.				
371	882	52	72	1·385	16·96	12·25	4·71
370	924	52	72½	1·394	17·77	12·74	5·03
359	952	48	71	1·479	19·83	13·41	6·42
365	952	46	70½	1·533	20·69	13·53	7·16

MODERATELY FAT BEASTS.

318	1148	48	77	1·604	23·91	14·91	9·00
302	1232	54	78	1·444	22·81	15·80	7·01
305	1400	57	82	1·439	24·56	17·07	7·49
185	1428	58	81	1·396	24·62	17·63	6·99

The data are arranged in the order of the live weights, and as it happens that this is practically the same as the order of fatness when ultimately worked out it might be inferred that the live weight is, by itself, a reliable index of condition. It is true that when animals are fully grown any change in their

weight (+ or −) indicates a change of condition and is an exact measure of the same, because the size remains constant. This, however, does not apply to growing animals, nor does it enable us to compare one with another. It will be seen, on reference to the table, that Nos. 359 and 365 have exactly the same weight, but the latter is 2in. shorter and ½in. less in girth, *i.e.*, it is altogether a smaller animal and could not, therefore, have the same weight unless it were in better condition,

It may be assumed that in any given animal the ratio of girth to length is a constant quantity, *i.e.*, that it is not affected by growth as apart from fattening, and that the length is independent of condition. If this be so, the size of the animal may be gauged by the latter dimension alone, and any change in condition (+ or −) will be determined by the variation in the ratio M/L. It should be possible, therefore, in this way, to compare the condition of the animal at all stages of growth, but not necessarily to compare one animal with another.

When two or more animals are to be compared it cannot be assumed that the ratio of girth to length is the same in all. The few examples given in the table show that it is not, and the ratio M/L cannot, therefore, be regarded as a reliable index of condition for the purpose of comparison. Thus, if two animals were of the same length, but of unequal girth, that which had the greater girth would weigh heavier and would show a higher ratio of live weight to length, though there was no difference in condition. The variation in the ratio G/L is, however, less than might be supposed. In the case of the store animals it ranged from 1·385 to 1·533, and in the case of the fat beasts from 1·396 to 1·604. The ratio M/L does, therefore, reflect the condition, and may even be regarded as a fairly approximate estimate of it.

Referring again to the table, it will be seen that the ratio M/G is always less than M/L, because, of course, G is always greater than L, but it varies in much the same manner. The order of fatness judged by either of these two ratios is the same. At first sight it appears as if the condition were reflected with equal accuracy by either, but as G is not independent of condition it is clear that such is not the case. It will also be noticed that though the ratio M/G varies in much the same manner as M/L, it does not vary in the same degree. The difference between them is greater in the case of fat beasts than in stores. This is probably attributable to the increase in girth which takes place when the condition of the animal improves. Any increase in the value of G diminishes the ratio M/G and so tends to increase the difference between M/L and M/G.

An attempt to estimate the increase in girth in this way showed that when the animals are moderately fat it is about

four per cent.; but when the method was applied to similar data from other sources it was found to be unsatisfactory.

Upon consideration, it seems clear that the increase must be some fractional part or percentage of the girth observed, *i.e.*, it must be I G/100. Now the ratio M/L varies with the degree of fatness, and, though not itself a reliable test of condition, it should afford a fairly close approximation to the value of I. Thus, when the animal is in store condition, *i.e.*, when there is no increase due to fattening, M/L = 17, and since, in that case, I is 0, I = (M/L − 17). Again, when the animal is moderately fat, M/L = 25, and since, in that case, the value of I is about 4, *i.e.*, about half the difference between 25 and 17, I = 0·5 (M/L − 17). The expression G/200 (M/L − 17), therefore represents the increase in girth due to fattening, and the original girth—which the animal would have had had it remained in store condition—may be found by subtracting that amount from the girth observed. In short, the expression G/200 (M/L − 17) represents the value of X in the provisional formula (page 5).

If the value of C be now worked out in each case it will be found that owing to the accident of the particular units employed (pounds and inches) the results are fractional numbers. For purposes of comparison it is more convenient to take the condition of the leanest animal—assumed to be a typical store—as 100, and that of the others *pro rata*. The factor required for this purpose is 424·4. The revised formula may now be written as follows:

$$C = \frac{424{\cdot}4\ M}{L\left(G - \frac{G}{200}(M/L - 17)\right)}$$

The original girth and present condition of each of the animals calculated by this formula is shown in the table below.

TABLE II.

STORES.				FAT BEASTS.			
No.	Girth Observed.	Original Girth.	Condition.	No.	Girth Observed.	Original Girth.	Condition.
371	72	72	100·0	302	77	75·7	127·4
370	72·5	72·3	104·5	318	78	74·3	136·5
359	71	70	120·2	305	82	78·9	132·1
365	70·5	69·2	129·2	185	81	77·9	134·1

It is noticeable that according to these results, Nos. 359 and 365, though classed as stores, are in nearly as good condition as those classed as fat, and there seems to be no reason to doubt the truth of this inference. The policy of maintaining an animal in the condition of No. 365 at that stage of growth cannot be discussed here; but it may be said in passing that one of the arguments by which it is sometimes supported—the more rapid increase in the live weight of young animals—seems to be beside the question. The additional weight which a young animal puts on is mainly, if not entirely, due to growth. There is nothing to show that a young animal puts on *true fattening increase* more rapidly or more easily than one which is fully grown. In the absence of some means of estimating condition —such as that now proposed—the question is a difficult one to investigate.

From a purely practical standpoint the condition of animals is of interest chiefly in regard to its bearing on the question of valuation. When animals are sold by weight, the rate by which the price is determined is fixed at so much per cwt., according to the condition of the animals. This rate, of course, fluctuates in accordance with the laws of economics, but it is suggested that if an animal whose condition is 100 be worth 28/- per cwt., then one whose condition is 130 should be worth 36/5 per cwt. In other words, if the rate for the typical store be 28/- that for any other animal of known condition should be 0·28 C.

When the rate per cwt. is fixed it is only necessary to multiply by the live weight (in cwts.) to find the actual price. If the live weight be given in pounds, this would be expressed as follows:

$$P = \frac{0{\cdot}28\ C \times M}{112}$$

or, if the formula be substituted for C:

$$P = \frac{0{\cdot}28 \times 424{\cdot}4 \times M \times M}{112\ L\left(G - \frac{G}{200}(M/L - 17)\right)} = \frac{1{\cdot}061\ M^2}{L\left(G - \frac{G}{200}(M/L - 17)\right)}$$

The rate per cwt. and corresponding price of each of the animals, calculated by this formula, are shown in Table III.

It will be seen that No. 302, though classed as fat, is valued at a slightly lower rate per cwt. than No. 365, which is classed

as store. The former, however, is estimated to be worth over £4 more than the latter because, of course, it is much bigger.

TABLE III.

STORES.			FAT BEASTS.		
No.	Rate per Cwt.	Price. £ s. d.	No.	Rate per Cwt.	Price. £ s. d.
371	28/-	11 0 6	302	35/8	19 12 5
370	29/3	12 1 5	318	38/3	19 11 9
359	33/8	14 6 1	305	37/-	23 2 6
365	36/2	15 7 6	185	37/6	23 18 9

It was not originally the intention of the author to enter upon the discussion of such practical matters at all. The object was merely to find some means of testing the condition for purposes of scientific experiment. Oxen are not infrequently put up to fatten before they are fully grown, and in such cases any inferences drawn from the increase in live weight must be of doubtful validity unless a distinction is made between true fattening increase and that due to growth.

The question of maintenance rations is also involved. The feeding standards quoted in the text-books are presumably based on the requirements of animals in "store" condition, whatever that may be. It is tolerably certain, however, that more food is required to maintain an animal in the fat or half-fat condition. If the rations of a fat beast were reduced to what is required to maintain it in store condition it would "go back," *i.e.*, it would lose weight and become thin again. At all events, the results obtained by different observers cannot be regarded as strictly comparable unless there be some assurance that the animals were at least approximately in the same condition. The question of maintenance rations is not only of considerable interest in itself, but it is of fundamental importance in connection with all feeding trials for any purpose whatever.

Though not favourably situated for collecting data of this kind, the author has obtained a few additional examples from three different sources. From the figures given in Table IV it will be seen that these broadly confirm the conclusions previously arrived at.

Special importance is attached to the results in group A (milk cows) because the observations were made by a trusted *colleague in the presence of the author, and every precaution

* Mr. Sidney Pennington, B.Sc., M.R.C.V.S., Lecturer on Agriculture and Manager of the Farm at University College, Reading.

was taken to ensure accuracy. The condition of the animals was described by practical experts in the following terms: the bull, very fairly fat; Rose, very good condition; Cherry, good condition; Countess, medium fair; Duchess, rather poorer, but above the average for milk cows. It was considered that the figures very fairly indicated the relative condition of the animals.

TABLE IV. ADDITIONAL EXAMPLES.

GROUP A.—MILK COWS.

Mark.	Live Weight.	Length.	Girth Observed.	$\frac{M}{L}$	$\frac{M}{G}$	Original Girth.	* Condition.
	pounds.	inches.	inches.			inches.	
Duchess	1116	52	72·5	21·46	15·39	70·9	128·5
Countess	1372	59	78	23·25	17·60	75·6	130·6
Cherry	1456	58	79·5	25·10	18·31	76·3	139·6
Rose	1680	60	86	28·00	19·53	81·3	146·2
Bull	2044	67	89	30·51	22·97	83·0	156·0

GROUP B.—STORES.

1	920	50·5	71	18·21	12·96	70·6	109·5
2	920	50·5	72·5	18·21	12·70	72·1	107·3
3	840	49·5	68	16·95	12·35	68·0	105·9
4	896	53·0	72	16·90	12·39	72·0	99·6
5	808	51·0	68	15·84	11·88	68·4	98·5
6	808	44·0	68	18·36	11·88	67·6	115·9

GROUP C.—FAT COWS.

1	1225	50·5	84	24·25	14·58	81·0	127·1
2	1230	49	84	25·10	14·64	80·6	132·2
3	1079	48	74·5	22·49	14·48	72·5	131·7
4	1129	48	72	23·51	15·68	69·7	143·3
5	1235	50	77·5	24·70	15·93	74·5	140·7

* Compared with No. 371 in Table I taken as 100.

In the case of No. 5, group B, it will be noticed that the condition is less than 100. In other words it is slightly inferior to that of No. 371, which was selected merely because it was the leanest in the first set of data obtained. If this animal be

accepted as a truly typical store, then the condition of No. 5 is below par. The average condition of the animals in group B is 106, and if that be taken as the normal (100) then the condition of No. 371 would be 94·3, and that of No. 5 only 92·9. The only positive inference that can be drawn is that more data are required.

In the case of the milk cows (group A) the length was measured between two vertical standards, one of which was placed against the point of the shoulder and the other in line with the extremity of the buttock. In the other cases it was measured by means of a tape along the back in the usual way. The latter method is far from satisfactory. It is possible that the several observers did not determine the points in exactly the same manner. In that case the different sets of data would not be strictly comparable one with another, though each set might be consistent in itself.

So far as it goes, however, the evidence is favourable to the principle of the method; but, for the present, the formula proposed (page 7) is offered merely as a hypothesis to be tested. The essential conditions of such a test are (1) to devise some method *or apparatus* for the measurement of length by which exactly the same results would be obtained by different observers, and (2) to accumulate a considerable mass of data relating to typical store and fat animals of different ages and breeds.

Neither of these conditions appears to present any insuperable difficulties, but they require the co-operation of expert judges of cattle whose words would be accepted. It is not anticipated that in order to obtain reliable results it will be found necessary to take very elaborate precautions such as would render the method useless to ordinary farmers; but even should this prove to be the case, the method, if definitely established, would still be invaluable to scientific investigators and to those who are called upon to advise farmers.

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